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# THE SAVANNAH RIVER SITE AND THE PROCESSING FACILITY BEING BUILT TO PREPARE ITS RADIOACTIVE WASTE FOR PERMANENT DISPOSAL

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J. R. Knight

E. I. du Pont de Nemours & Co.
Savannah River Plant
Aiken, South Carolina 29808



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The Savannah River Plant has been operating a full nuclear fuel cycle since the early 1950's. At the site, fuel and target elements are produced and irradiated to make plutonium and tritium for use by the Department of Defense (Figure 1). After removal from the reactors, elements are processed for extraction of the plutonium and tritium. Uranium is recycled and fission products and contaminated chemical wastes are sent to waste storage. During the thirty years of operation, about 270 million liters of high-level radioactive waste has been generated. The Defense Waste Processing Facility (DWPF) presently under construction at Savannah River will process this waste into a form suitable for long term geologic disposal.[1]

The waste is presently stored in alkaline form in 5-million-liter carbon steel tanks. In the alkaline form, most metal ions precipitate as hydroxides. The alkali metals stay in solution. To conserve storage space, the salt solution is concentrated by evaporation causing a large fraction of the soluble salts to fall out also. The waste in the tanks therefore exists in three forms, sludge, salt cake, and saturated salt solution (Figure 2). Most of the radioactive components are in the sludge; the principal exception is $^{137}Cs$ which is in both salt cake and supernate.

The original reference process for the DWPF called for removal of the cesium from the salt solution and salt cake by ion exchange, mixing of the cesium and sludge, and incorporation of the mix into a borosilicate glass. The original price tag was about $3 billion. Process development in the Savannah River Laboratory in the last several years has brought the estimated cost under $900 million. The single most significant cost reduction was the development of a process to precipitate the cesium in the waste tanks as cesium tetraphenylborate.[2] Project scope reductions, other in-tank processes, and process refinements also contributed to cost savings.

The waste process now includes the following steps:

Prior to transfer to the DWPF

- Dissolution of the salt cake from the tanks
- Precipitation of the $^{137}Cs$ from the salt solution
- Dissolution of the aluminum from the sludge using caustic
- Combining of the decontaminated salt solution and solubilized aluminum with Portland cement and flyash for disposal as a cement form.

Within the DWPF

- Separate transfer of sludge and tetraphenylboron precipitate to the DWPF

- Removal of the organic portion of the cesium precipitate by hydrolysis with formic acid
- Mixing of cesium and sludge
- Addition of glass frit
- Slurry feeding of frit and waste to a continuous glass melter
- Pouring of glass into stainless steel canisters for storage and ultimate disposal.

The total mass of dissolved and undissolved solids in the SRP wastes at the time of startup of the DWPF will be approximately $1.5 \times 10^8$ kg. Incorporation of this quantity of material in a borosilicate glass form and transportation to a national high-level waste repository would be prohibitively expensive. The actual mass of radioactive components is much less, approximately $1.8 \times 10^5$ kg. Clearly, any disposal process would have to include at least a partial separation of radioactive and nonradioactive components. With the planned loading of waste in the glass, the actual reduction in mass to be sent to a repository is approximately 17-fold.

The principal nonradioactive component of the sludge is the large quantity of aluminum in SRP waste. Because aluminum is amphoteric, it can be selectively solubilized from the sludge by increasing the pH. Sodium hydroxide will be added to the sludge to raise the pH and then the sludge will be filtered and washed. The aluminum bearing wash solution is still radioactive so it must then be combined with the salt solution for decontamination.

The salt solution is decontaminated by adding sodium tetraphenylborate and sodium titanate. The tetraphenylborate will remove the radioactive cesium and the sodium titanate will remove traces of plutonium and strontium by adsorption. The decontaminated salt solution will then be ready for disposal as a cement grout called saltstone; the sludge and the cesium precipitate will be sent to the DWPF (Figure 3).

The processing of highly radioactive solutions is very expensive, largely because it must be done behind considerable shielding and all air passing over the process must be thoroughly decontaminated. Consequently, the sludge washing and tetraphenylborate precipitation steps have been developed for operation within the existing waste tanks. This has eliminated one entire remote processing canyon building from the original DWPF design. Figure 4 is a picture of an existing canyon facility at SRP; Figure 5 is a picture of the new DWPF facility under construction.

Inside the DWPF, the waste will be mixed with glass frit and fed to a melter. Although some of the organics present in the process can be burned off in the melter, it is not being designed to handle all of them. Therefore, the tetraphenylborate precipitate must be hydrolyzed to remove the benzene groups before being fed to the melter. The resulting slurry of sodium titanate and cesium formate will be mixed with the sludge and frit. The waste will then be slurry-fed to the melter (Figure 6).

The waste bearing glass will be poured into stainless steel canisters for interim storage and ultimate disposal in a national repository. The canisters are 2 feet in diameter and 9 feet 10 inches high. They will be welded shut using an upset welding technique developed at the Savannah River Laboratory.

The DWPF is presently under construction and is due for completion in 1989. The Savannah River Laboratory is presently confirming specific designs through the operation of prototypical equipment using nonradioactive simulants. Many of the process steps are new to SRP and some have never been carried out in a remote facility. Before radioactive waste is introduced to the DWPF in late 1989, the remote operation of all equipment and all process steps must be demonstrated. Several of the specific areas of process development are described in other presentations in this session. These presentations will provide an appreciation for the tremendous chemical processing challenges met in the development of the DWPF process.

**ACKNOWLEDGMENT**

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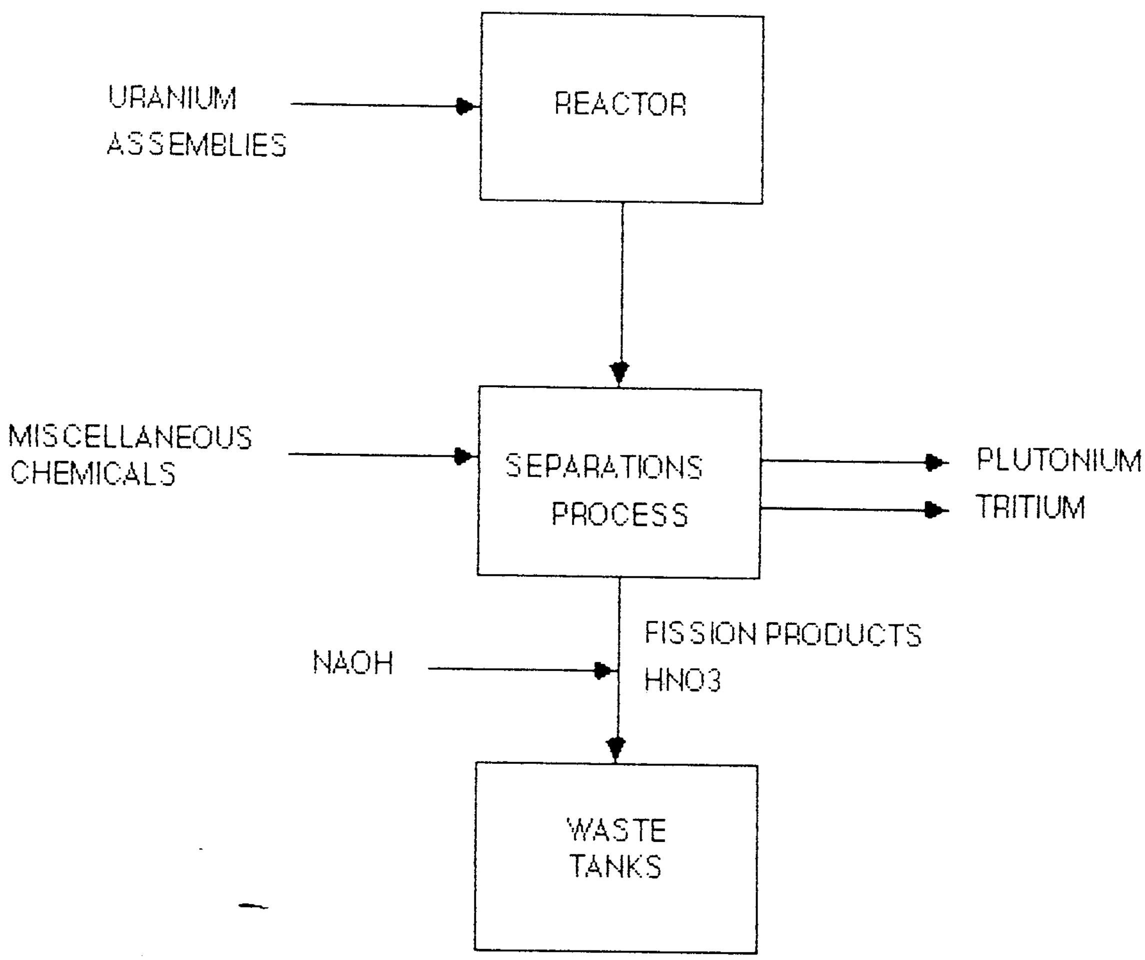


**FIGURE 1. High Level Waste Generation at Savannah River**

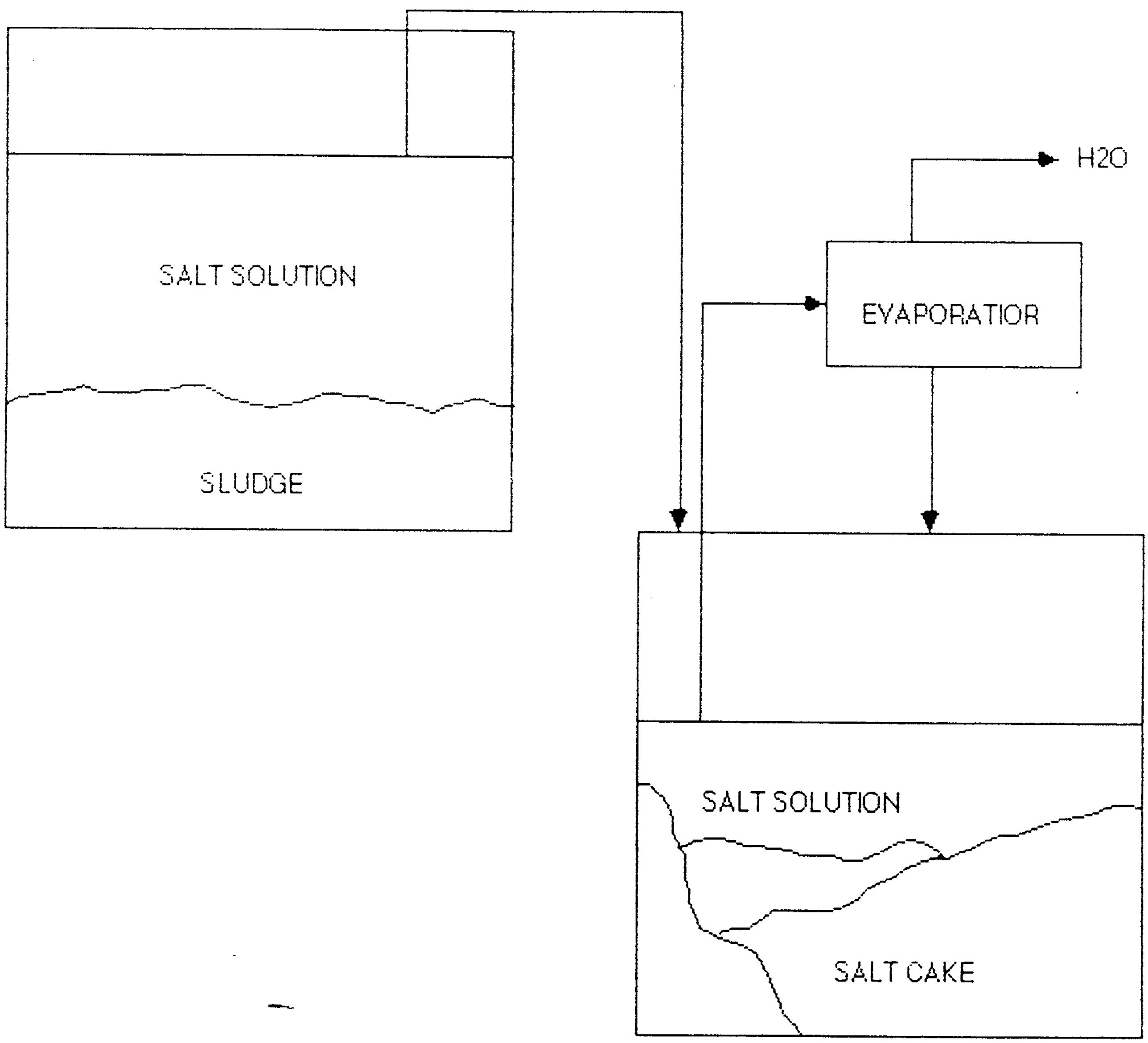


**FIGURE 2. High Level Waste Storage and Volume Reduction**

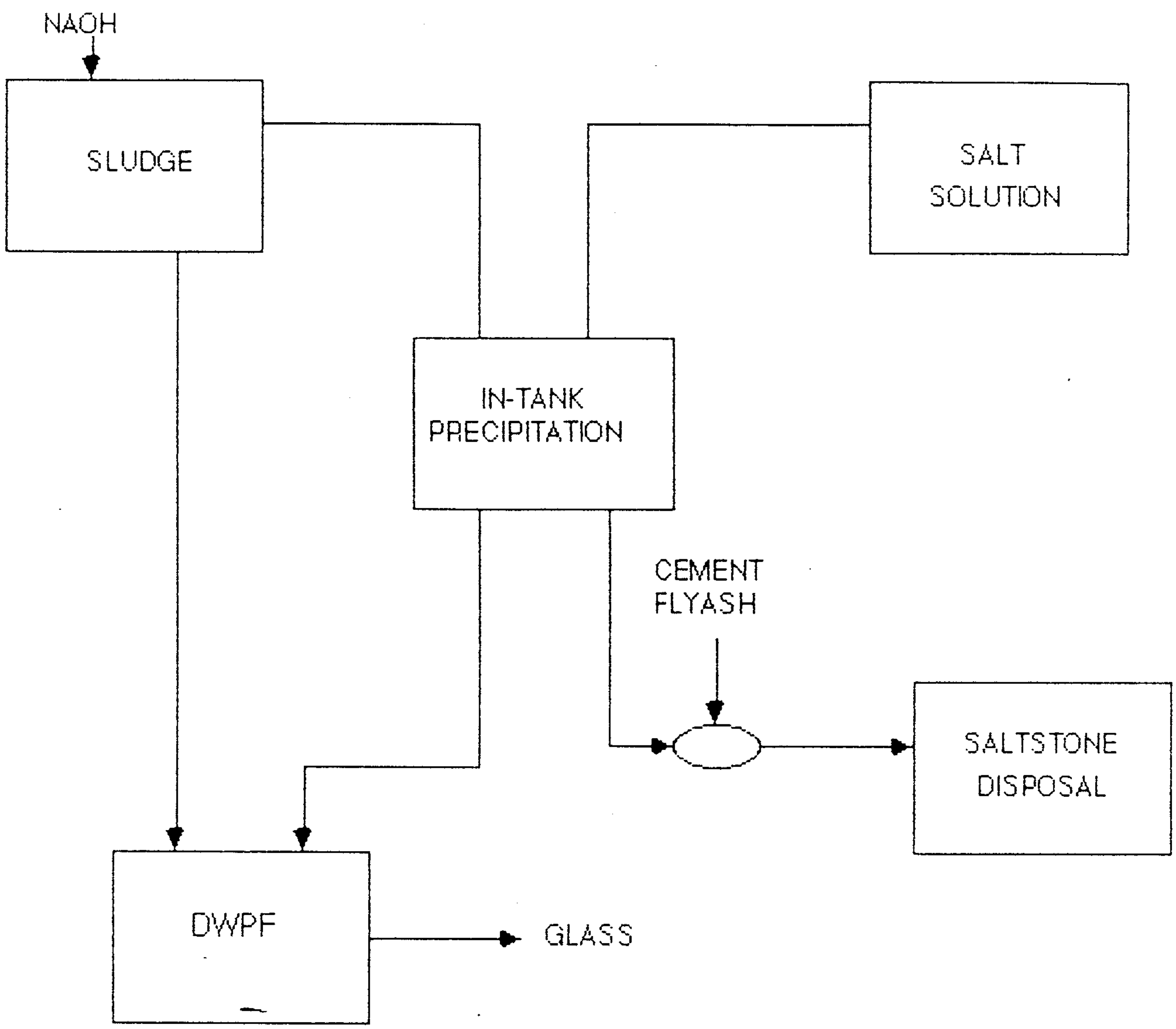


**FIGURE 3. Waste Solidification Flow Sheet**

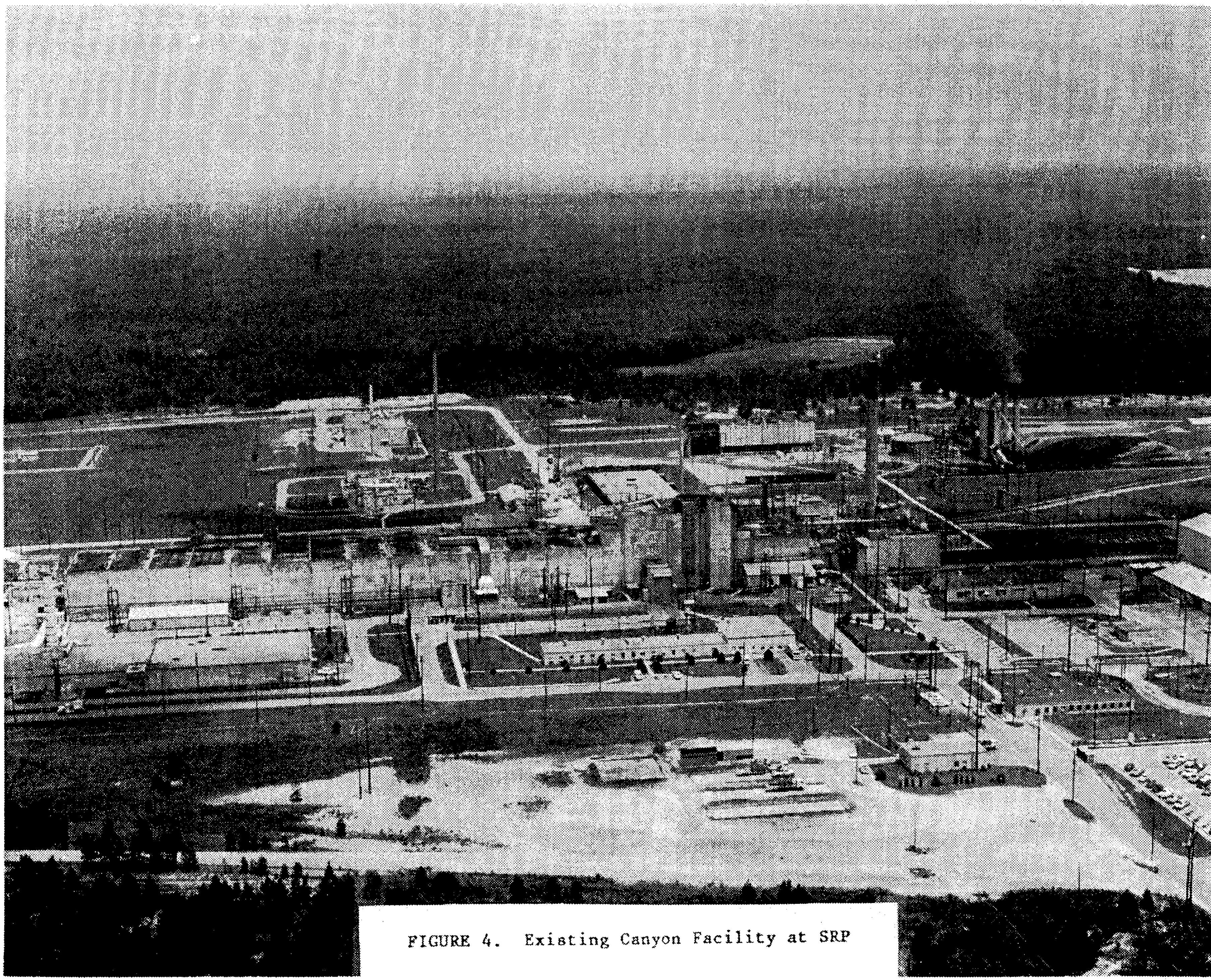

FIGURE 4. Existing Canyon Facility at SRP

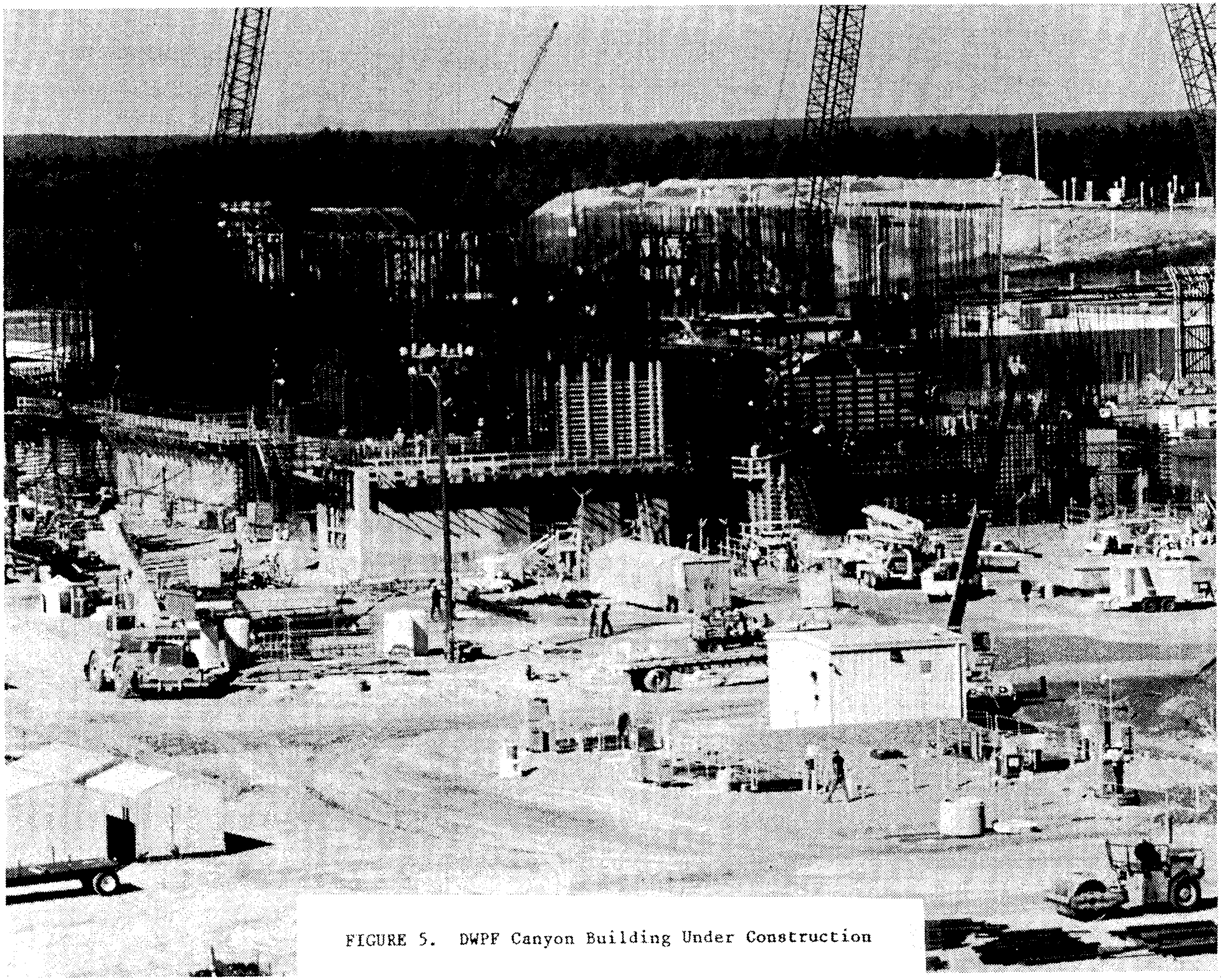

FIGURE 5. DWPF Canyon Building Under Construction